B/13

PROCEEDINGS

International Seminar on Agro-tourism Development (ISAD)

AGRO-TOURISM: EDUCATING, CONSERVING, AND EMPOWERING

Hosted by:

Faculty of Agriculture
Universitas Pembangunan Nasional "Veteran" Yogyakarta
Indonesia

Held on:
December 6th - 8th, 2011

ISBN : 978-979-18768-1-0

Supported by:

University of Western Sydney

http://isad.upnyk.ac.id

Proceedings

International Seminar on Agro-tourism Development (ISAD 2011)

AGRO-TOURISM:
EDUCATING, CONSERVING AND EMPOWERING

Field Trip held on 6 December 2011

Seminar held on 7 - 8 December 2011
in Faculty of Agriculture, UPN "Veteran" Yogyakarta
Indonesia

ISBN: 978-979-18768-1-0

INFLUENCE OF AGGREGATE STABILITY ON INFILTRATION

Subroto Padmosudarso
Agrotechnology Department, Faculty of Agriculture,
Universitas Pembangunan Nasional "Veteran" Yogyakarta
Jl. SWK 104 Condong Catur Yogyakarta, Indonesia
Email: subroto_ps@yahoo.co.id

ABSTRACT

Coastal land in Indonesia is very a broad and potential as tourist object so it needs to be manage as optimal medium for plant growth well in order to beautify the tourist sites, the land consists of sandy soil that have limiting factor on water so the water management in sandy land is very urgent. To necessity above authors conducted research on the influence of aggregate stability on infiltration as contribution thought in water management on sandy land. Most of the processes, involving soil water flow in the field and especially in the rooting zone of most plant habitats, occur while the soil is in unsaturated condition. To achieve this objective two sandy soils of different aggregate stability were used, were exposed to specific rainfall and the infiltrations of water through the soil were measured. The soils used in this study were collected from a depth 0 -50 cm , in area planted with sugar beat. The area is located at Assenade, 25 km North of Ghent Belgium. The soils were designated as Soil A collected from a depth 0 -15 cm and Soil B collected from a depth 15 – 30 cm and mixed with that from 30 – 50 cm .The physical and chemical analized values are the average of 3 replicates. The result show the higher aggregate stability the better infiltration. Consequently to keep better agregate we should maintain organic mater and calcium carbonate content and this will result in higher available water content for plant growth.

KEYWORDS : coastal land, sandy soil, infiltration, aggregate stability

INTRODUCTION

Practically we are concernd wit two sets of factors, when dealing with soil aggregation : Those responsible for aggregate formation and those which give the aggregates stability.Since both sets of factors operate simultaneously is difficult to separate relative effects on stable granule devlopment in soils (Brady,1974) .

The effect of an agronomic system on soil microbial and earthworm activity, as a source of organic matter, also exerts a pronounced effect on aggregation.

Microbial activity appears to affect soil aggregation in different ways were : filaments of microbial tissues may form a network within mineral particles, produce polysaccharides that leave a mucilaginous nature and may cement mineral particles, microorganisms produce non-polysaccharide organic residues of various kinds that may aid in binding mineral particles (Gabriels and De Boodt, 1976).

the volume, size and continuity of non-capillary pores, because such pores provide easy paths for the movement of percolating water.

The most important parameters influencing the rate of infiltration deal with the physical characteristics of the soil and also with the cover of the soil.

The influence of the texture and the structure stability is also important, since the porosity depends on both of them. Soil structure, stable to wetting, has a great chance of maintaining an open surface infiltrability and hence permeability to water.

Due to the impact of raindrops soil crumbs can be destroyed, which means slaking of aggregates, so that very small particles of silt and clay can penetrate into previously existing pores. Thus clogging them and consequently reducing the infiltration.

Vegetative cover and surface conditions can have a greater influence on the infiltration rate than the soil type and texture.

MATERIALS AND METHODS

Material

The soils used in this study were collected from a depth of 0 - 50 cm, in an area planted with sugar beat and/or maize. The area is located at Assenede, 25 km North of Ghent.Belgia. The soils were designated as : Soil A collected from a depth 0 - 15 cm, soil B collected from a depth 15 - 30 cm and mixed with that from a depth 30 - 50 cm.

Methods

Physical and chemical characteristics

The physical and chemical characteristics performed on the soils were :Texture, aggregate stability, pF, bulk density, organic matter content, calcium carbonate, pH H_2O & pH KCl, and Ec 1/5

1. **Determination of the particle size distribution**
   Determination of the partiicle size distribution with pipette method.
2. **Determination of the aggregate stability**
   The dry and wet sieving were caried out according to the method described by DE Leenheer and De Boodt (1967).
3. **Determination of the pF**
   For the suction range between 0 - 0.2 bar, the hanging water column method is used. In the higher suction range (0.2 - 15 bar) a positive gas - pressure a cross a porous ceramic membrane is used.
4. **Determination of the bulk density.**
   Used gamma ray attenution equipment (Verplanke, 1973).
5. **Determination of organic matter content**
   The organic matter content has been determined by Walkey and Black method.
6. **Determination of calcium carbonate**
   Carbonates were destroyed with 0.5 N H_2SO_4. The excess H_2SO_4 was filtrated against standard NaOH.

3. Aggregate stability

The results of the aggregate stability measurements are presented in Table 3.1. and Table 3.2. Soil B has a better aggregate stability than Soil A as shown by the values of stability indices (Table 3.2).

Table 3.1. Aggregate size distribution (%) of Soil A and Soil B before and after wet sieving

Fraction (mm)	Soil A Before	(g)* After	Soil A Before	(g)* After
8.0 – 4.76	40	20.61	40	31.60
4.76 – 2.83	32	17.43	32	23.72
2.83 – 2.0	28	16.36	28	16.57
2.0 – 1.0		10.15		8.02
1.0 – 0.5		11.58		5.17
0.5 – 0.3		8.01		4.40
< 0.3		15.85		10.51

*The values are the average of 3 replicates

Table 3.2. Mean weight diameter and stability index of soil A and soil B

Soil	Mean weight Dry sieving	Diameter Wet sieving	Sability Index
Soil A	4.45	2.45	1.78
Soil B	4.45	3.51	0.94

*The values are the average of 3 replicates

If one looks to the organic matter content presented in the Table 1.1. one should expect a lower stability index for Soil A than for Soil B. Indeed Soil A contains 2.5 % O.M. against 1.7 % for Soil B. The only reason for this rather strange behaviour could be attributed to the presence of another stabilization agent namely $CaCO_3$. The $CaCO_3$ content 15 4.5 % in Soil B and 3.7 % Soil A. It is probably the combined effect of Organic matter and $CaCO_3$ which resulted in a different stability index for Soil A and Soil B.

4. Soil Water characteristic

The soil water characteristics of the soils (fraction < 2 mm), are presented in Table 4.1.

Table 4.1. Soil water characteristics of Soil A and Soil B (fraction < 2 mm)

Soil water potential (bar)	pF	Soil Water Content: Soil A g/g	Soil A cm^3/cm^3	Soil B g/g	Soil B cm^3/cm^3
0.01	1	0.468	0.515	0.463	0.505
0.36	2.54	0.167	0.184	0.145	0.158
14.71	4.2	0.090	0.099	0.082	0.089

* The values are the average of 3 replicates

The bulk density was determined in rings used for the pF - curves. The mean bulk density for Soil A was 1.09 $g.cm^{-3}$ and 1.10 $g.cm^{-3}$ for Soil B.

The difference in infiltration depth between the different aggregate size fractions is only quite obvious for the fraction < 2 mm. This fraction shows also the lowest depth of wetting and is due to the fact that the more aggregated the toplayer the better is the (saturated) hydraulic conductivity and consequently followed by a. depper wetting front.

It may conclude from these experiments that the depth of wetting depends on the aggregate size distribution and the aggregate stability.

Consequently it is extremely important to maintain the level of organic matter content in the soil as high as possible. If the depth of wetting is improve this will result in a higher available water content for plant growth and a reduction in runoff .

Table 6.2. Depth of infiltration during simulated, rainfall of Soil A and Soil B with the variation of aggregate size on top 2 cm-of the soil columns

	Depth of infiltration (cm) *							
Time (min)	Fraction 2 mm		Fraction 2.0 – 2.83 mm		Fraction 2.83 – 4.76 mm		Fraction 4.76 – 8.0 mm	
	A	B	A	B	A	B	A	B
10	2.2	2.1	0.9	1.2	2.7	2.8	2.4	2.6
20	3.0	2.8	1.8	1.7	4.0	4.3	3.1	3.5
30	3.7	3.8	3.7	2.8	5.9	5.6	3.9	4.4
40	4.3	4.7	4.5	3.7	7.4	7.2	4.3	5.3
50	5.2	5.7	5.7	4.5	8.6	9.0	5.4	6.5
60	5.6	5.4	6.7	5.2	9.5	10.3	6.3	7.4
70	6.2	7.0	7.7	6.5	10.4	10.9	6.8	8.4
80	6.9	8.0	8.2	7.5	11.2	11.7	7.3	9.0
90	7.2	8.4	9.0	9.2	12.4	12.6	8.5	10.3
100	7.6	8.9	10.0	10.0	13.2	13.2	9.4	11.1
110	8.3	9.7	10.5	10.5	14.0	14.3	10.6	12.3
120	8.5	10.0	11.0	11.0	14.3	14.7	11.0	12.6
130	8.9	10.5	12.2	12.2	15.0	15.2	12.0	13.4
140	9.6	11.4	13.0	12.8	15.8	15.9	13.6	14.8
150	9.9	11.9	13.8	13.8	16.1	16.1	14.0	15.3
160	10.4	12.5	14.8	14.8	16.7	16.6	14.8	16.0
170	11.2	13.3	15.5	15.8	17.2	17.2	16.3	17.4
180	11.4	13.6	16.2	16.5.	17.4	17.4	16.9	17.8

*The values are average of 3 replicates

SUMMARY AND CONCLUSIONS

The aim of this study was to investigate the effect of aggregate stability on infiltration.

The experiments were conducted in simulated laboratory conditions close to field conditions introducing the rainfall which in reality controls infiltration.

In this study four experiments, each consisting of eight soil columns were carried out. For each eicperiment faur columns with Soil A and faur columns with Soil B were used. Soil A soil B have the same particle size distribution and differ only in O.M. content and % CaCO. The surface layer of each soil column consisted of a fraction < 2.0 mm, 2.0 -2.83 mm, 2.83 - 4.76 mm,and 4.76 - 8.0 mm respectively, 2 cm thick of either Soil A or Soil B. The infiltration tests were carried out using a rainfall simulator.

The following summarizes the findings and conclusions from the study :

1. Soil A and Soil B have some identical physical characteristics like texture, and soil water characteristic,. However there are some differences in the chemical properties such as organic matter and calcium carbonate content. These differences are reflected in the stability of the soil aggregates. The results show that Soil B is much more stable than Soil A.
   The difference in aggregate stability might explain the differences in the vertical infiltration under a simulated rainfall especially for the fraction < 2 mm and 4.76 mm - 8.0 mm.
   For those soil physical properties the O.M. content plays a more important role due to the influence on the soil water. The small differences are due to the differences in the O.M. content between Soil A and Soil B.
2. The results of this study have shown that there is some effect of the aggregate stability on the vertical infiltration. Improving the aggregate stability of the soil surface by adding organic matter will consequently improve the available water content for the plant growth and reduce the runoff.

REFERENCES

Ahn P. M., 1979. Microaggregation in Tropical Soils. Its measurement and effects on the maintenance of soil productivity In "Soil Physical conditions and crop production in the tropics" (R.Lal and D.J. Greenland),Wiley, Chichester pp. 25 - 86.

De Boodt, M. 1976. Soil conditioning; its roots and its meaning for future. Med. Fak. Landbouw. Rijksuniv. Sent 40;19 - 22.

De Leenheer, L and M. De Boodt,1967.Aggregate stability determination by the change in mean weightdiameter. In West-Eurepean Methods for Soil Stucture Determination. Ed. By the West- Eurepean Workingt Group on Soil Struture of the ISSC, Ghent, VI,28.

Edwards, A. P. and J. M. Bremner. 1967. Microaggregates in soils J. Soil Sci. 18; 47 - 63.